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ABSTRACT

Focusing on environmental scientists and conservation occupations, this document is one in a series of forty-one reprints from the Occupational Outlook Handbook providing current information and employment projections for individual occupations and industries through 1985. The specific occupations covered in this document include foresters, forestry technicians, range managers, soil conservationists, geologists, geophysicists, meteorologists, and oceanographers. The following information is presented for each occupation or occupational area: a code number referenced to the Dictionary of Occupational Titles; a description of the nature of the work; places of employment; training, other qualifications, and advancement; employment outlook; earnings and working conditions; and sources of additional information. In addition to the forty-one reprints covering individual occupations or occupational areas (CE 017 757-797), a companion document (CE 017 756) presents employment projections for the total labor market and discusses the relationship between job prospects and education. (BM)

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ED158123

Environmental Scientists and Conservation Occupations

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Reprinted from the
Occupational Outlook Handbook,
1978-79 Edition.

U.S. Department of Labor
Bureau of Labor Statistics
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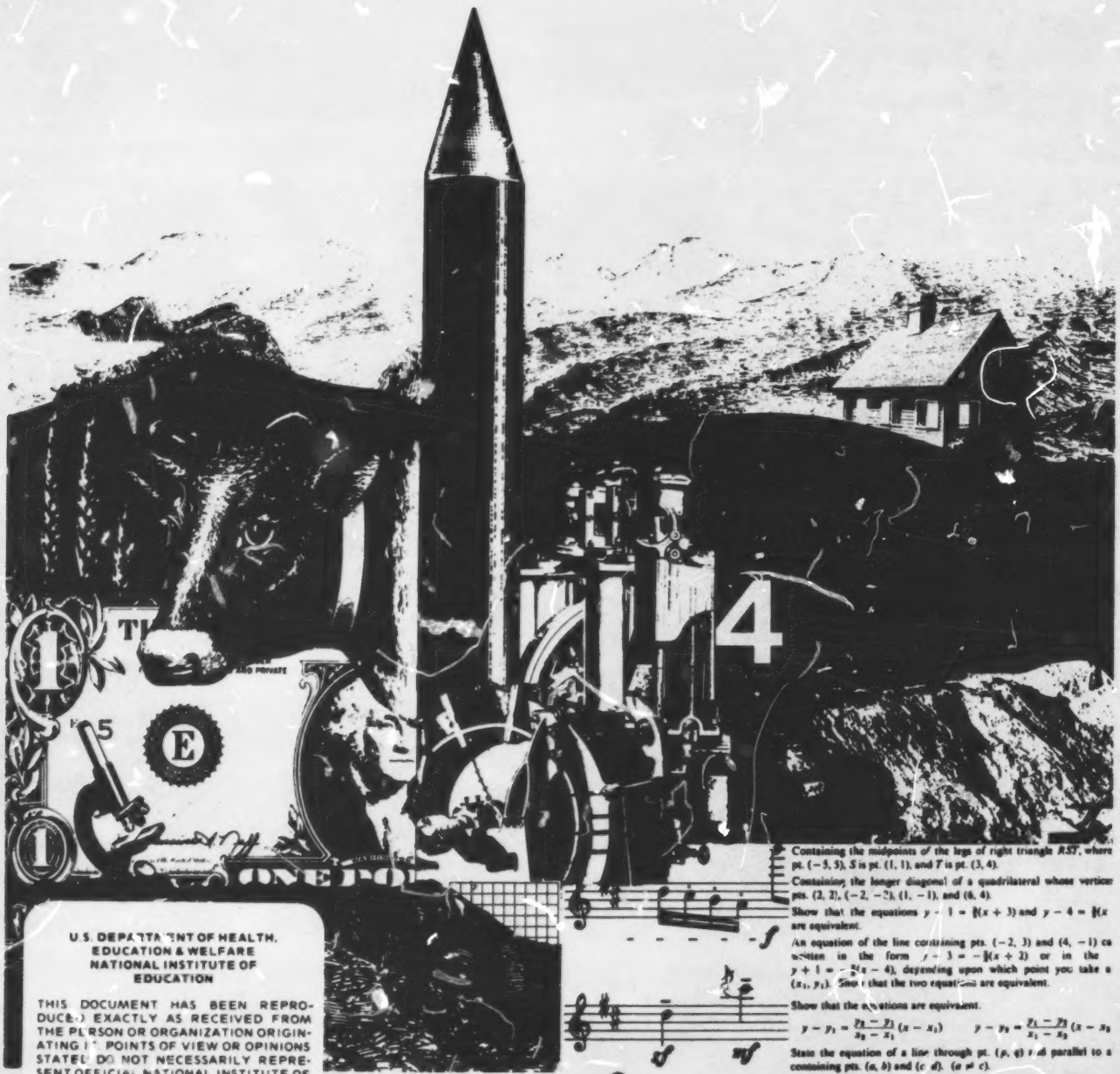

Containing the midpoints of the legs of right triangle *RST*, where pt. (−5, 5), *S* is pt. (1, 1), and *T* is pt. (3, 4).

Containing the longer diagonal of a quadrilateral whose vertices pts. (2, 2), (−2, −2), (1, −1), and (6, 4).

Show that the equations $y - 1 = \frac{1}{2}(x + 3)$ and $y - 4 = \frac{1}{2}(x$ are equivalent.

An equation of the line containing pts. (−2, 3) and (4, −1) ca written in the form $y - 3 = -\frac{1}{2}(x + 2)$ or in the $y + 1 = -\frac{1}{2}(x - 4)$, depending upon which point you take a (x_1, y_1). Show that the two equations are equivalent.

Show that the equations are equivalent.

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) \qquad y - y_2 = \frac{y_1 - y_2}{x_1 - x_2}(x - x_2$$

State the equation of a line through pt. (p, q) and parallel to a containing pts. (a, b) and (c, d). $(a \neq c)$.

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CE 017 773

CONSERVATION OCCUPATIONS

Forests, rangelands, wildlife, soil, and water are important natural resources. Conservationists protect, develop, and manage these resources to assure that future needs will be met.

Persons interested in a career in conservation must have specialized training. Foresters, range managers, and soil conservationists generally need bachelor's degrees in their fields. Technical school is usually required for positions as forestry technicians. In addition to technical knowledge and skills, conservationists must have a sincere interest in the environment and the desire to protect it. They should enjoy dealing with others and like public service, since they often work with people in the community. Flexibility also is important, since a conservationist may work in a remote camping area one week, speak to a community group the next, and fight a forest or brush fire the next.

This section describes four conservation occupations—forester, forestry technician, range manager, and soil conservationist.

FORESTERS

(D.O.T. 040.081)

Nature of the Work

Forests are a vital natural resource. They can be used repeatedly without being destroyed—if properly managed. The condition of our environment has become a major national concern, and foresters play an important role in protecting that environment by ensuring that our forests are properly used. Foresters manage, develop, and protect these lands and their resources—timber, water, wildlife, forage, and recreational areas.

Foresters plan and supervise the cutting and planting of trees. They also protect the trees from fire, harmful insects, and disease. Foresters may be responsible for other duties ranging from wildlife protection and watershed management to the development and supervision of camps, parks and grazing lands.

Foresters also do research, provide forestry information to forest owners and to the general public (called extension work), and teach at colleges and universities.

Foresters spend considerable time outdoors in all kinds of weather.

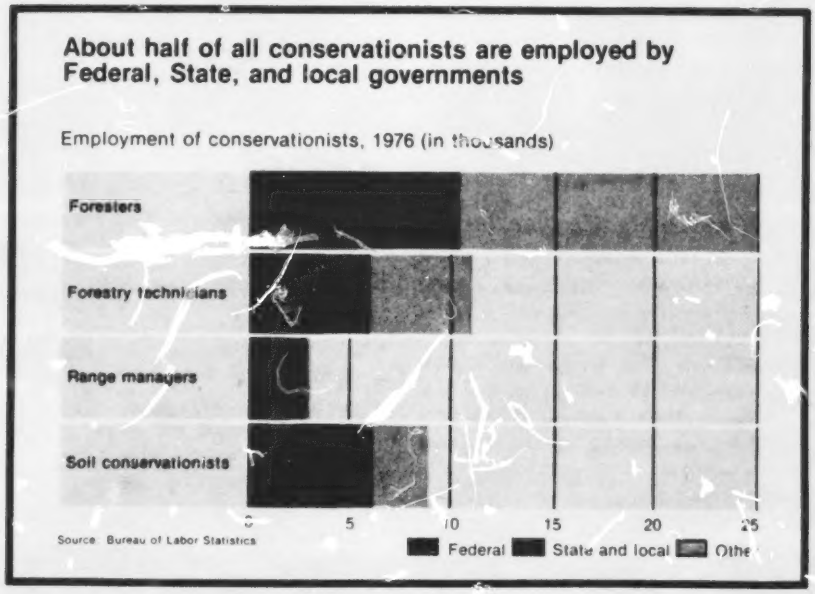
Foresters often specialize in one area of work, such as timber management, outdoor recreation, or forest economics. Some of these areas are recognized as distinct professions.

Places of Employment

About 25,000 persons worked as foresters in 1976. Nearly 2 out of 5 worked in private industry, mainly for pulp and paper, lumber, logging, and milling companies. About one-fourth worked for the Federal Government, primarily in the Forest Service of the Department of Agriculture. The remainder worked for State and local governments, colleges and universities, or consulting firms or were self-employed, either as consultants or forest owners.

Training, Other Qualifications, and Advancement

A bachelor's degree with a major in forestry is the minimum educational requirement for those desiring professional careers in forestry. However, due to keen job competition and the increasingly complex nature of the forester's work, employers prefer graduates who hold advanced degrees. Certain jobs such



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as teaching and research require advanced degrees.

Education in forestry leading to a bachelor's or higher degree was offered in 1976 by 50 colleges and universities, of which 43 were accredited by the Society of American Foresters. Curriculums stress the liberal arts and communications skills as well as technical forestry subjects. Most programs also include courses in forest economics and business administration to supplement the student's scientific and technical knowledge. Many colleges require students to spend one summer in a field camp operated by the college. All schools encourage summer jobs that give firsthand experience in forest or conservation work.

In addition to meeting the intellectual demands of forestry, foresters must enjoy working outdoors, be physically hardy, and be willing to move, often to remote places. Foresters should also be able to work well with people and be able to express themselves clearly.

Forestry graduates usually work under the supervision of experienced foresters. After gaining experience, they may advance to more responsible positions. In the Federal Government, an experienced forester may supervise an entire forest area, and may advance to regional forest supervisor or to a top administrative position. In private industry, foresters start by learning the practical and administrative aspects of the business. Many foresters work their way up to top managerial positions within their companies.

Employment Outlook

Employment requirements for foresters are expected to grow about as fast as the average for all occupations through the mid-1980's. In recent years, however, the number of persons earning degrees in forestry has exceeded occupational requirements, creating competition for jobs. If the number of degrees granted each year remains at present levels, competition is expected to persist throughout the period. Opportunities will be better for those who can offer an employer either an advanced degree or several years' experience.

The country will need more foresters in the future to ensure an increasing output of forest products. Employment also may increase as we become more aware of the need to conserve and replenish our forest resources, and to improve the environmental quality of our forest lands.

Private owners of timberland may well employ more foresters as they recognize the need for—and the higher profitability of—improved forestry and logging practices. The forest products industry will require additional foresters to apply new techniques for using the entire forest crop, to develop methods of growing superior trees in a shorter period of time, and to do research in the fields of plant genetics and fertilization.

Employment of foresters will probably continue to grow faster in private industry than in the Federal Government where budget limitations may restrain growth. State government agencies will probably hire more foresters through Federal-State cooperative programs for fire control, protection against insects and disease, recreation, and technical assistance to owners of forest lands.

The expected rapid increase in the employment of forestry technicians will reduce the amount of time spent by foresters in performing routine tasks, but the forester will have to devote more and more time to supervisory work and to the general management of the forest.

Earnings and Working Conditions

The average starting salary for foresters in 1976 was $10,000 a year, while experienced foresters averaged over $18,000, according to the limited data available.

In private industry, starting foresters averaged $10,300 a year in 1976 and the overall average salary was $17,700, according to the limited data available.

Graduates entering the Federal Government as foresters in 1977 with just a bachelor's degree started at $9,203 a year. However, because of keen competition, most foresters hired by the Federal Government either held a master's degree or had some experience, and generally started at $11,523 a year. Ph. D.'s generally started at $14,097 or $17,056 a year. The median annual salary in 1977 for federally employed foresters exceeded $20,000.

In local government, foresters generally began at about $10,700 a year in 1976, while their median annual salary was $15,400. State governments paid about $9,200 annually to start in 1976, and State median salaries were $15,400 per year. College professors generally started at about $11,000 annually in 1976, while their median salary was over $20,000 per year. Many faculty foresters supplement their regular salaries with income from lecturing, consulting, and writing.

Many experienced foresters advance to jobs which require them to spend most of their time in an office. However, the beginning forester spends considerable time outdoors in all kinds of weather, sometimes in remote areas. Foresters may also work extra hours on emergency duty, as in fire fighting or search and rescue missions.

Sources of Additional Information

General information about the forestry profession, lists of reading materials, and lists of schools offering education in forestry are available from:

Society of American Foresters, 5400 Grosvenor Lane, Washington, D.C. 20014.

National Forest Products Association, 1619 Massachusetts Ave., NW., Washington, D.C. 20036.

General career information is also available from:

American Forest Institute, 1619 Massachusetts Ave. NW., Washington, D.C. 20036.

American Forestry Association, 1319 18th St. NW., Washington, D.C. 20036.

For details on forestry careers in the Forest Service, contact:

U.S. Department of Agriculture, Forest Service, Washington, D.C. 20250.

FORESTRY TECHNICIANS

(D.O.T. 441.137 through 441.887)

Nature of the Work

Forestry technicians, sometimes called forestry aides in entry level positions, assist foresters in the care and management of forest lands and their resources. (See statement on foresters earlier in this chapter.)

Forestry technicians help estimate present and potential timber production in a certain area. If new roads are needed to make the timber accessible for cutting and removal, technicians may supervise the surveying and road building crews. After the timber has been cut, they measure the logs to determine how much lumber the trees will yield and then assist in the sale of the timber.

Technicians work on many forest improvement projects. They inspect trees for disease and other problems, and record their findings. On watershed projects, they work to prevent flood damage and soil erosion and seek ways to increase the quality of water in the forest.

Forestry technicians also help to prevent and control fires. They give fire prevention information to people using the forest and lead firefighting crews if a fire occurs. After fires are extinguished, they take inventory of burned areas and supervise the planting of new trees and shrubs to restore the forest.

Recreational use of the forest has increased greatly. Technicians maintain forest areas for hunting, camping, hiking, and other recreational activities. They also explain forest regulations and policies to visitors and enforce these rules.

Forestry technician measuring the diameter of a tree.

Places of Employment

About 11,000 persons worked year round as forestry technicians in 1976. Nearly the same number found temporary employment—primarily with Federal and State Governments—during the summer or in the spring and fall fire seasons.

Nearly half the year-round total worked in private industry, mainly for logging, lumber, and paper companies. Reforestation projects of mining, oil, and railroad companies—as well as employment in tree nurseries—accounted for the remainder of the workers in private employment. The Federal Government employed about 3,700 full-time forestry technicians in 1976, primarily in the Forest Service of the U.S. Department of Agriculture, while another 2,200 worked for State governments.

Training, Other Qualifications, and Advancement

Most persons qualify for beginning jobs as forestry technicians by completing a specialized course of study in a 1- or 2-year postsecondary school or through work experience on firefighting crews, in tree nurseries, or in recreation work.

Because of keen job competition at the present time, opportunities for employment are better for those with postsecondary school training. In 1976, about 80 technical institutes, junior or community colleges, and universities offered forestry technician training, of which 53 are recog-

nized by the Society of American Foresters.

Most forestry technician schools require graduates to complete general education courses such as mathematics and English, forestry-related courses including biology and botany, and specialized forest technology courses such as land surveying, tree identification, aerial photograph interpretation, and timber harvesting. To gain practical experience, students may be required to work in a forest or camp operated by the school.

Enthusiasm for outdoor work, physical stamina, and the ability to carry out tasks with and without direct supervision are essential for success in this field. Technicians should be able to work with survey crews, users of the forest lands, forest owners, and foresters. They must express themselves clearly when talking to others and when making written reports.

Forestry technicians generally begin work as trainees or in relatively routine positions under the direct supervision of an experienced technician or forester. As technicians gain experience, they are given more responsibility, and often move into supervisory positions. Some technicians obtain bachelor's degrees in forestry and are promoted to the forester level.

Employment Outlook

Growth in employment of forestry technicians is expected to be faster than the average for all occupations through the mid-1980's. Private industry should continue to provide a high proportion of these jobs.

Environmental concern, a rising demand for forest products and increased use of technology in the forest industry are expected to stimulate demand for more technicians each year. Trained technicians will be required to operate specialized and efficient laborsaving machines and to help apply sophisticated scientific methods to forest management. Technicians will also increasingly perform many of the more routine jobs done by foresters.

Despite this expected growth, keen competition for jobs is anticipated. Currently, the number of persons seeking employment as forestry technicians greatly exceeds the jobs available. Unless the number of graduates of forestry technician schools declines substantially in the future, this keen competition for jobs is expected to continue. Those offering specialized forestry technician training and some practical experience may have better opportunities.

Earnings and Working Conditions

Starting salaries of forestry technicians ranged from $7,500 to $10,000 a year in 1976, according to the limited data available; experienced forestry technicians averaged about $12,300.

In the Federal Government, forestry technicians started at $8,316 or $9,303 a year in 1977 depending on education and experience. Experienced forestry technicians in the Federal Government averaged between $12,000 and $13,000 annually.

Forestry technicians spend considerable time outdoors in all kinds of weather, sometimes in remote areas. In emergencies, such as fighting fires and controlling floods, forestry technicians work many extra hours. Climatic conditions often limit year-round field work, and firefighting jobs are limited to the fire season.

Sources of Additional Information

Information about a career in the Federal Government as a forestry technician is available from:

U.S. Department of Agriculture, Forest Service, Washington, D.C. 20250.

For a list of schools recognized by the Society of American Foresters offering training in the field write to:

Society of American Foresters, 5400 Grosvenor Lane, Washington, D.C. 20014.

RANGE MANAGERS

(D.O.T. 040.081)

Nature of Work

Rangelands cover more than 1 billion acres of the United States, mostly in the Western States and Alaska. They contain many natural resources: grass and shrubs for animal grazing, habitats for livestock and wildlife, water from vast watersheds, facilities for water sports and other kinds of recreation, and valuable mineral and energy resources. Rangelands also serve as areas for scientific study of the environment.

Range managers, sometimes called *range scientists*, *range ecologists*, or *range conservationists*, manage, improve, and protect range resources to maximize their use without incurring ecological destruction. For example, range managers determine the number and kind of animals to be grazed, the grazing system to be used, and the best season for grazing in order to yield a high production of livestock. At the same time, they must conserve soil and vegetation for other uses such as wildlife habitat, outdoor recreation, and timber production.

Range managers restore and improve rangelands through techniques such as controlled burning, reseeding, and biological, chemical, or mechanical control of undesirable plants. For example, selected rangelands with natural sagebrush vegetation may be plowed and reseeded with a more productive grass. Range managers also determine the need for and carry out range conservation and development such as providing for animal watering facilities, erosion control, and fire prevention.

Not all of the range manager's time is spent outdoors. Office work is not unusual. The range manager may consult with other conservation specialists, prepare written reports, and perform certain administrative duties.

Because of the multiple use of rangelands, range managers often work in such closely related fields as wildlife and watershed management, forest management, and recreation.

Places of Employment

About 3,000 persons worked as range managers in 1976. The majority worked for the Federal Government, principally for the Forest Service and the Soil Conservation Service of the Department of Agri-

Range managers may spend considerable time away from home working outdoors in remote parts of the range.

culture and the Bureau of Land Management of the Department of the Interior. Range managers in State governments are employed in game and fish departments, State land agencies, and extension services.

An increasing number of range managers are working for private industry. Coal and oil companies employ range managers to help restore the ecological balance to mined out areas. Banks and real estate firms employ them to help increase the revenue from their landholdings. Other range managers work for private consulting firms and large livestock ranches.

Some range managers with advanced degrees teach and do research at colleges and universities. Others work overseas with United States and United Nations agencies and with foreign governments.

Training, Other Qualifications, and Advancement

A bachelor's degree with a major in range management or range science is the usual minimum educational requirement for range managers. In the Federal Government, a degree in a closely related field, such as agronomy or forestry, including courses in range management and range science, may also be accepted. Graduate degrees in range management are generally required for teaching and research positions, and may be helpful for advancement in other jobs.

In 1976, about 20 colleges and universities had degree programs in range management or range science. A number of other schools offered course work in range management.

A degree in range management requires a basic knowledge of biology, chemistry, physics, mathematics, and communication skills. Specialized courses combine plant, animal, and soil sciences with principles of ecology and resource management. Desirable electives include economics, computer science, forestry, wildlife, and recreation.

Federal Government agencies, primarily the Forest Service, the Soil Conservation Service, and the Bureau of Land Management, hire some college students for summer jobs in range management. This experience may better qualify these students for jobs when they graduate.

Besides having a love for the outdoors, range managers should be able to write and speak effectively and work with others. They should have the ability to work alone or under direct supervision. Good physical health and stamina also are important.

Employment Outlook

Employment of range managers is expected to grow faster than the average for all occupations through the mid-1980's. Job opportunities throughout this period are expected to be good for persons with degrees in range management or range science. Also, some jobs may be filled by persons with degrees in related fields who have had some range management courses.

An increasing demand for meat and other rangeland products should stimulate the need for more range managers. Since the amount of rangeland is generally fixed, range managers will be needed to increase the output of rangelands while protecting their ecological balance. Also, more range managers will be needed as the number of large livestock ranches increases.

As oil and coal exploration accelerates, private industry will probably require many more range specialists to rehabilitate ecologically disturbed areas.

The use of rangelands for other purposes such as wildlife protection and recreation could create additional needs for range managers. Federal hiring for these activities depends heavily upon legislation concerning the management of range resources.

Earnings and Working Conditions

In the Federal Government, range managers with the bachelor's degree started at either $9,303 or $11,523 in 1977, depending on their college grades. Those having 1 or 2 years of graduate work began at $11,523 or $14,097; persons with Ph. D. degrees started at either $14,097 or $17,056 a year. Range managers with the Federal Government averaged about $20,000 a year in 1977.

Salaries for range managers who work for State governments and private companies are about the same as those paid by the Federal Government, according to limited data.

Range managers may spend considerable time away from home working outdoors in remote parts of the range.

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Sources of Additional Information

Information about a career as a range manager as well as a list of schools offering training is available from:

Society for Range Management, 2760 W. 5th Ave. Denver, Col. 80204.

For information about career opportunities in the Federal Government, contact:

Bureau of Land Management, Denver Service Center, Federal Center Building 50, Denver, Col. 80255.

Forest Service, U.S. Department of Agriculture, Washington, DC. 20250.

Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C. 20250.

SOIL CONSERVATIONISTS

(D.O.T. 040.081)

Nature of the Work

Soil conservationists provide technical assistance to farmers, ranchers, and others concerned with the conservation of soil and water. They help farmers and other land managers develop programs that make the most productive use of land without damaging it. Soil conservationists do most of their work in the field. If a farmer is experiencing an erosion problem, the conservationist will visit the farm, find the source of the problem, and develop a program to combat the erosion. For example, if the erosion is caused by water runoff on sloped fields, the conservationist may recommend ways to terrace the land, or construct pathways for the runoff that do not remove soil. If erosion results from wind, the conservationist may recommend growing hedges in places that will provide windbreaks or may suggest improved methods of farming, such as leaving the wheat or corn stalks on the field after harvesting to provide ground cover.

In many areas of the country—particularly in the West—rainfall is insufficient to permit the growing of crops. Much of this land, however, can be made suitable for grazing livestock if proper water conservation techniques are used. Soil conservationists inspect rangeland and recommend to range managers areas where ponds can be constructed to provide water for livestock. They also recommend solutions to problems of overgrazing, such as seeding grassland or placing salt licks in undergrazed areas to keep the livestock away from areas that have been overgrazed. In this manner they can distribute herds so that the concentration of animals in any one area does not exceed the replaceable food supply.

Soil conservationists pay close attention to weather patterns in order to be aware of conservation problems before they arise. During the winter months, they make periodic snowmobile or ski patrols into the Rockies and other mountainous areas of the West to measure snowfall. This enables them to predict the spring and summer water runoff. In years when the snowfall is light, they

Soil conservationist provides farmer with technical assistance.

alert range managers and farmers to possible water shortages, and develop appropriate water conservation measures.

In addition to working with individual farmers and ranchers, soil conservationists are assigned to work as technical advisors to Soil and Water Conservation Districts when solving areawide land management problems. A Soil and Water Conservation District is made up of a group of individuals within a county who are concerned with, and responsible for, conservation problems within that county. Soil conservationists working with Conservation Districts prepare maps of the district or parts of the district, depicting particular problems of soil and water conservation. They then use the maps to develop a conservation program for the entire area, whether it is only a few farms and ranches or an entire watershed.

Places of Employment

An estimated 7,500 soil conservationists were employed in 1976, mostly by the Federal Government in the U.S. Department of Agriculture's Soil Conservation Service or in the Department of the Interior's Bureau of Indian Affairs. Soil conservationists employed by the Department of Agriculture work as advisors for Soil and Water Conservation Districts in almost every county in the country. Those employed by the Bureau of Indian Affairs generally work near or on Indian reservations, most of which are located in the Western States. In addition to those who work for the Federal Government, others are employed by State and local governments, and some teach at colleges and universities.

Other soil conservationists are employed by rural banks, insurance firms, and mortgage companies that make loans for agricultural lands. A few also work for public utilities, and lumber and paper companies that have large holdings of forested lands.

Training, Other Qualifications, and Advancement

Very few colleges and universities offer degrees with a major in soil conservation. Most soil conservationists, especially those employed by the Soil Conservation Service, have degrees in agronomy. A few soil conservationists have degrees in related fields of the natural resource sciences, such as wildlife biology, forestry, and agricultural education. Programs of study generally must include 30 semester hours in natural resources or agriculture, including at least 3 hours in soils.

A background in agricultural engineering is very helpful to soil conservationists, and courses in cartography, or mapmaking, also are helpful. Soil conservationists must be able to communicate well with people, since much of their work deals with educating farmers and ranchers in sound conservation practices. Also, they must be able to prepare written reports and plans of programs to present to farmers, range managers, and Soil and Water Conservation Districts.

Opportunities for advancement are somewhat limited. However, conservationists working at the county level may advance to the State level. Also, soil conservationists can transfer to related occupations such as farm management advisor or land appraiser. Those with advanced degrees may find teaching opportunities in colleges and universities.

Employment Outlook

Employment of soil conservationists is expected to increase about as fast as the average for all occupations through the mid-1980's. In addition to employment growth, several hundred openings will occur each year from the need to replace conservationists who die, retire, or transfer to other occupations. For example, even though employment of conservationists in the Soil Conservation Service has not increased over the past decade, the Department of Agriculture has hired, on the average, about 400 new conservationists each year.

Employment growth will occur in banks, public utilities, and other organizations that make loans on agricultural lands or that have large holdings of farm or ranch lands. Many of these organizations are adding conservationists to their staffs to help preserve the value of farmlands on which they hold mortgages or to help them comply with recent conservation and anti-pollution laws. In addition, as concern for the environment and interest in conserving the productivity of agricultural lands increases, a larger number of colleges should add soil conservation majors to their degree programs, which would increase the demand for soil conservationists to fill teaching positions. However, because this is a very attractive job choice for many people, competition for jobs as soil conservationists may make it difficult to find jobs in this field.

Earnings and Working Conditions

Soil conservationists who had a bachelor's degree and were employed by the Federal Government received $9,303 a year in 1977. Advancement to $11,523 could be expected after 1 year of satisfactory service. Those who had outstanding records in college, or who had a master's degree, started at $11,523 and could advance to $14,097 after 1 year. Further advancement depends upon the individual's ability to accept greater responsibility. Earnings of well-qualified Federal soil conservationists with several years' experience range from $17,056 to $28,725 a year.

Because soil conservationists do most of their work in the field, this may be an ideal career for a person who enjoys working outdoors. Usually during periods of bad weather they work in their offices, but occasionally they have to work outdoors in inclement weather.

Sources of Additonal Information

Additional information on employment as a soil conservationist may be obtained from the U.S. Civil Service Commission, Washington, D.C. 20415; Employment Division, Office of Personnel, U.S. Department of Agriculture, Washington, D.C. 20250; or any office of the Department's Soil Conservation Service.

ENVIRONMENTAL SCIENTISTS

Environmental scientists help us understand our natural environment—the earth, its atmosphere, and the oceans. These scientists, sometimes known as earth scientists, are concerned with the history, composition, and characteristics of the earth's surface, interior, and atmosphere. Some do basic research to increase scientific knowledge, while others do applied research, using knowledge gained from basic research to help solve practical problems. Geologists, for example, may explore for new sources of oil and other minerals, while many meteorologists forecast the weather. Environmental scientists also play an important role in solving environmental pollution problems. Many environmental scientists teach in colleges and universities.

This chapter discusses four environmental science occupations—geologists, geophysicists, meteorologists, and oceanographers.

GEOLOGISTS

(D.O.T. 024.081)

Nature of the Work

Geologists study the structure, composition, and history of the earth's crust. By examining surface rocks and drilling to recover rock cores, they determine the types and distribution of rocks beneath the earth's surface. They also identify rocks and minerals, conduct geological surveys, draw maps, take measurements, and record data. Geological research helps to determine the structure and history of the earth and may result in significant advances such as the ability to predict earthquakes. An important application of geologists' work is locating oil and other minerals.

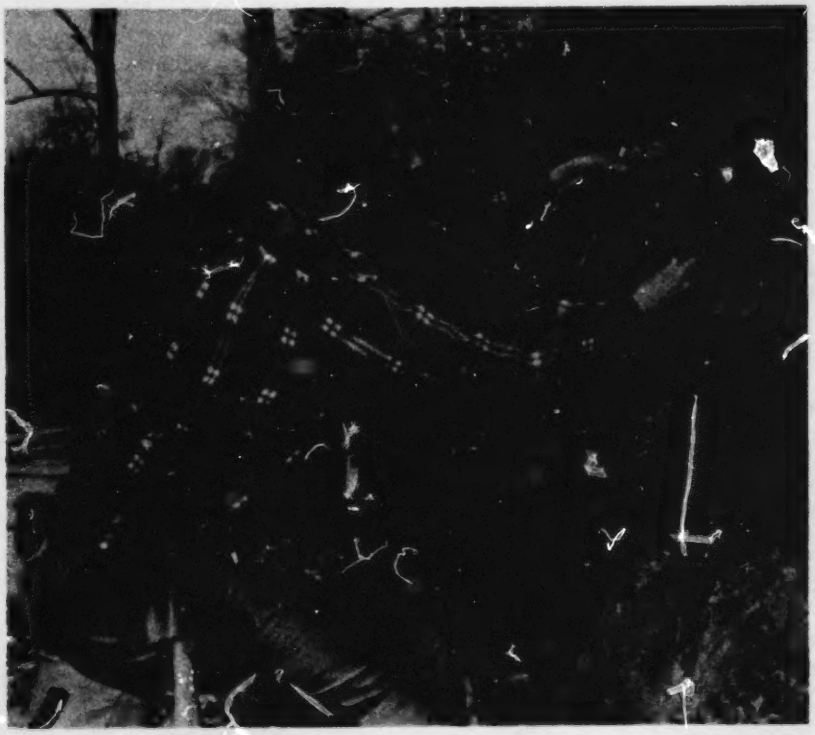
Geologists use many tools and instruments such as hammers, chisels, levels, transits (mounted telescopes used to measure angles), gravity meters, cameras, compasses, and seismographs (instruments that record the intensity and duration of earthquakes and earth tremors). They may evaluate information from photographs taken from aircraft and satellites and use computers to record and analyze data.

Geologists also examine chemical and physical properties of specimens in laboratories under controlled temperature and pressure. They may study fossil remains of animal and vegetable life or experiment with the flow of water and oil through rocks. Laboratory equipment used by geologists includes complex instruments such as the X-ray diffractometer, which determines the structure of minerals, and the petrographic microscope, used for close study of rock formations.

Besides locating resources and working in laboratories, geologists also are called on to advise construction companies and governmental agencies on the suitability of certain locations for constructing buildings, dams, or highways. Some geologists administer and manage research and exploration programs. Others teach and work on research projects in colleges and universities.

Geologists usually specialize in one or a combination of three general areas—earth materials, earth processes, and earth history.

Economic geologists locate earth materials such as minerals and solid fuels. *Petroleum geologists* search for and recover oil and natural gas. Some petroleum geologists work near drilling sites and others correlate petroleum related geologic information for entire regions. *Engineering geologists* determine suitable sites for the construction of roads, airfields, tunnels, dams, and other structures. They decide, for example, whether underground rocks will bear the weight of a building or whether a proposed structure may be in an earthquake-prone area. *Mineralogists* analyze and classify minerals and precious stones according to composition and structure. *Geochemists* study the chemical composition and changes in minerals and rocks to understand the distribution and migration of elements in the earth's crust.



Geologist examining surface rocks.

Geologists concerned with earth processes study land forms and their rock masses, sedimentary deposits (matter deposited by water or wind) and eruptive forces such as volcanoes. *Volcanologists* study active and inactive volcanoes, and lava flows and other eruptive activity. *Geomorphologists* examine landforms and those forces, such as erosion and glaciation, which cause them to change.

Other geologists are primarily concerned with earth history. *Paleontologists* study plant and animal fossils to trace the evolution and development of past life. *Geochronologists* determine the age of rocks and land forms by the radioactive decay of their elements. *Stratigraphers* study the distribution and arrangement of sedimentary rock layers by examining their fossil and mineral content.

Many geologists specialize in new fields that require knowledge of another science as well. *Astrogeologists* study geological conditions on other planets. *Geological oceanographers* study the sedimentary and other rock on the ocean floor and continental shelf. (See statements on oceanographers and mining elsewhere in the *Handbook*.)

Places of Employment

More than 34,000 people worked as geologists in 1976. More than three-fifths of all geologists work in private industry. Most industrial geologists work for petroleum companies. Geologists also work for mining and quarrying companies. (See statements on the mining and petroleum industries elsewhere in the *Handbook*.) Some are employed by construction firms. Others are independent consultants to industry and government.

The Federal Government employs over 2,000 geologists. Two-thirds work for the Department of the Interior in the U.S. Geological Survey, the Bureau of Mines, and the Bureau of Reclamation. State agencies also employ geologists, some working on surveys in cooperation with the U.S. Geological Survey.

Colleges and universities employ about 9,500 geologists. Some work for nonprofit research institutions and museums.

Employment of geologists is concentrated in those States with large oil and mineral deposits. Almost two-thirds work in five States: Texas, California, Louisiana, Colorado, and Oklahoma. Some are employed by American firms overseas for varying periods of time.

Training, Other Qualifications, and Advancement

A bachelor's degree in geology or a related field is adequate for entry into some geology jobs. An advanced degree is helpful for promotion in most types of work, and is essential for college teaching and many research positions.

About 300 colleges and universities offer a bachelor's degree in geology. Undergraduate students devote about one-fourth of their time to geology courses, including physical, structural and historical geology, mineralogy, petrology, and invertebrate paleontology, about one-third of their time taking mathematics, related sciences—such as physics and chemistry—and engineering; and the remainder on general academic subjects.

More than 160 universities award advanced degrees in geology. Graduate students take advanced courses in geology and specialize in one branch of the science.

Students planning careers in exploration geology should like the outdoors, and must have physical stamina.

Geologists usually begin their careers in field exploration or as research assistants in laboratories. With experience, they can be promoted to project leader, program manager, or other management and research positions.

Employment Outlook

Employment opportunities in geology are expected to be good for those with degrees in geology or in a related science with courses in geology. The employment of geologists is expected to grow faster than the average for all occupations through the mid-1980's. This growth will create many new openings each year. Many additional openings will be created each year by geologists who retire, die, or leave the occupation.

Increased prices for petroleum and the necessity to locate new sources of other minerals as older sources become exhausted will stimulate domestic exploration activities and require many additional geologists. Additional geologists also will be needed to discover new resources and their potential uses. For example, geologists will help determine the feasibility of using geothermal energy (steam from the earth's interior) to generate electricity. Geologists are needed to devise techniques for exploring deeper within the earth's crust and to develop more efficient methods of mining resources. They also are needed to develop adequate water supplies and waste disposal methods, and to do site evaluation for construction activities.

Earnings and Working Conditions

Geologists have relatively high salaries, with average earnings over twice those of nonsupervisory workers in private industry, except farming.

According to a survey done by the College Placement Council, in early 1977 graduates with bachelor's degrees in other physical and earth sciences received average starting offers of $13,300 a year. Graduates with master's degrees in geology and related geological sciences received average starting offers of $14,900 per year.

In the Federal Government in 1977, geologists having a bachelor's degree could begin at $9,303 or $11,523 a year, depending on their college records. Those having a master's degree could start at $11,523 or $14,097 a year; those having the Ph. D. degree at $17,056 or $20,442. In 1977, the average salary for geologists employed in the Federal Government was over $25,000 a year.

Conditions of work vary. Exploration geologists often work overseas. Geologists travel to remote sites by helicopter and jeep, and cover large areas by foot, often working in teams. Geologists in mining sometimes work underground. When not working outdoors, they are in com-

fortable, well-lighted, well-ventilated offices and laboratories.

Sources of Additional Information

General information on training and career opportunities for geologists is available from:

American Geological Institute, 5205 Leesburg Pike, Falls Church, Va. 22041.

For information on Federal Government careers, contact:

Interagency Board of U.S. Civil Service Examiners for Washington, D.C., 1900 E St. NW., Washington, D.C. 20415.

GEOPHYSICISTS

(D.O.T. 024.081)

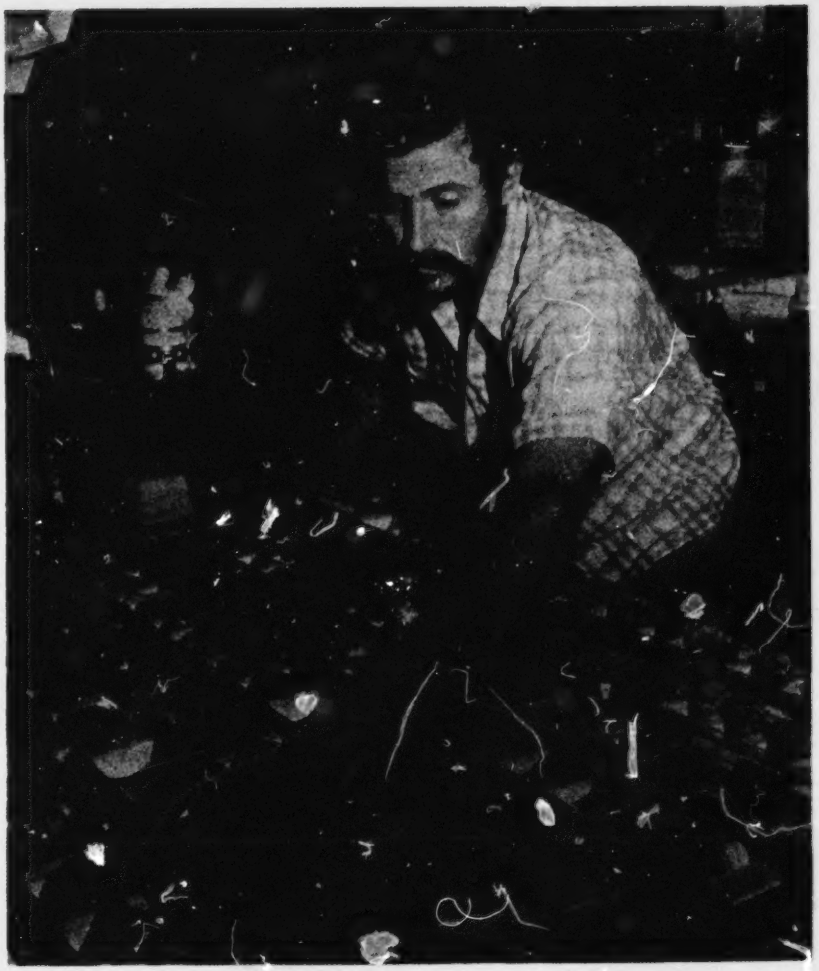
Nature of the Work

Geophysicists study the composition and physical aspects of the earth and its electric, magnetic, and gravitational fields. Geophysicists use highly complex instruments such as the magnetometer which measures variations in the earth's magnetic field, and the gravimeter which measures minute variations in gravitational attraction. They often use satellites to conduct tests from outer space and computers to collect and analyze data.

Geophysicists usually specialize in 1 of 3 general phases of the science—solid earth, fluid earth, and upper atmosphere. Some may also study other planets.

Solid earth geophysicists search for oil and mineral deposits, map the earth's surface, and study earthquakes. *Exploration geophysicists* use seismic prospecting techniques to locate oil and mineral deposits. They send sound waves into the earth and record the echoes bouncing off the rock layers below to determine if conditions are favorable for the accumulation of oil.

Seismologists study the earth's interior and earth vibrations caused by earthquakes and manmade explosions. They explore for oil and minerals, study underground detection of nuclear explosions, and provide information for use in constructing bridges, dams, and buildings. For example, in constructing a dam, seismologists determine where bedrock (solid rock beneath the soil) is closest to the surface so the best dam site can be selected. They use explosives or other methods to create sound waves that reflect off bedrock; the time it takes for the shock wave to return to the surface indicates the depth of bedrock. Seismologists also seek to understand the causes of earthquakes so that one day they might be predicted.



Some geophysicists work in research laboratories.

Geodesists study the size, shape, and gravitational field of the earth and other planets. Their principal task is precise measurement of the earth's surface. With the aid of satellites, geodesists determine the positions, elevations, and distances between points on the earth, and measure the intensity and direction of gravitational attraction.

Hydrologists are concerned with the fluid earth. They may study the distribution, circulation, and physical properties of underground and surface waters, including glaciers, snow, and permafrost. They also may study rainfall and its rate of infiltration into soil. Some are concerned with water supplies, irrigation, flood control, and soil erosion. (See statement on oceanographers, sometimes classified as geophysical scientists, elsewhere in the *Handbook*.)

Geophysicists also study the atmosphere, investigate the earth's magnetic and electric fields, and compare its outer atmosphere with those

of other planets. *Geomagneticians* study the earth's magnetic field. *Paleomagneticians* learn about past magnetic fields from rocks or lava flows. *Planetologists* study the composition and atmosphere of the moon, planets, and other bodies in the solar system. They gather data from geophysical instruments placed on interplanetary space probes or from equipment used by astronauts during the Apollo missions. *Meteorologists* sometimes are classified as geophysical scientists. (See statement on meteorologists elsewhere in the *Handbook*.)

Places of Employment

About 12,000 people worked as geophysicists in 1976. Most work in private industry, chiefly for petroleum and natural gas companies. (See statement on the mining and petroleum industry elsewhere in the *Handbook*.) Others are in mining companies, exploration and consulting firms, and research institutes. A few are independent consultants and some do geophysical prospecting on a fee or contract basis.

Geophysicists are employed in many southwestern and western States, and in those on the Gulf Coast, where large oil and natural gas fields are located. Some geophysicists are employed by American firms overseas for varying periods of time.

Almost 2,300 geophysicists, geodesists, and hydrologists worked for Federal Government agencies in 1976, mainly the U.S. Geological Survey; the National Oceanic and Atmospheric Administration (NOAA); and the Defense Department. Other geophysicists work for colleges and universities, State governments, and nonprofit research institutions.

Training, Other Qualifications, and Advancement

A bachelor's degree in geophysics or a geophysical specialty is sufficient for most beginning jobs in geophysics. A bachelor's degree in a related field of science or engineering also is adequate preparation, provided the person has courses in geophysics, physics, geology, mathematics, chemistry, and engineering.

Geophysicists doing research or supervising exploration activities should have graduate training in geophysics or a related science. Those planning to teach in colleges or do basic research should acquire a Ph. D. degree.

About 50 colleges and universities award the bachelor's degree in geophysics. Other programs offering training for beginning geophysicists include geophysical technology, geophysical engineering, engineering geology, petroleum geology, and geodesy.

More than 60 universities grant the master's and Ph. D. degree in geophysics. Candidates with a bachelor's degree which includes courses in geology, mathematics, physics, engineering, or a combination of these subjects can be admitted.

Geophysicists often work as part of a team. They should be curious, analytical, and able to communicate effectively.

Most new geophysicists begin their careers doing field mapping or exploration. Some assist senior geophysicists in research laboratories. With experience, geophysicists can advance to jobs such as project leader or program manager, or other management and research jobs.

Employment Outlook

Employment opportunities are expected to be very good for graduates with a degree in geophysics or a related field, though few openings are expected. Nevertheless, the number of people qualified to enter the field may fall short of requirements if present trends in the number obtaining geophysics training continue.

Employment of geophysicists is expected to grow faster than the average for all occupations through the mid-1980's. As known deposits of petroleum and other minerals are depleted, petroleum and mining companies over the next decade will need increasing numbers of geophysicists who can use sophisticated electronic techniques to find less acessible fuel and mineral deposits.

In addition, geophysicists with advanced training will be needed to do research on radioactivity and cosmic and solar radiation and to investigate the use of geothermal power (steam from the earth's interior) as a source of energy to generate electricity.

Federal agencies are expected to hire more geophysicists for new and expanding programs. Through the mid-1980's, jobs will depend heavily on funds for research and development in earth sciences as the Government supports energy research in both established and alternative sources. The Government also may fund research to locate more natural resources and to prevent environmental damage through better land use.

Earnings and Working Conditions

Geophysicists have relatively high salaries, with average earnings more than twice those of nonsupervisory workers in private industry, except farming.

According to a survey done by the College Placement Council, in early 1977 graduates with bachelor's degrees in other physical and earth sciences received average starting offers of $13,300 a year. Graduates with master's degrees in geology and related geological sciences received average starting offers of $14,900 per year.

In the Federal Government in 1977, geophysicists having a bachelor's degree could begin at $9,303 or $11,523 a year, depending on their college records. Geophysicists having a master's degree could start at $11,523 or $14,841 a year; those having a Ph. D. degree, at $17,056 or $20,442. In 1977, the average salary for geophysicists employed by the Federal Government was about $24,500 a year.

Many geophysicists work outdoors and must be willing to travel for extended periods of time. Some work at research stations in remote areas, or aboard ships and aircraft equipped with sophisticated geophysical equipment. When not in the field, geophysicists work in modern, well-equipped, well-lighted laboratories and offices.

Sources of Additional Information

General information on career opportunities, training, and earnings for geophysicists is available from:

American Geophysical Union, 1909 K St. NW., Washington, D.C. 20006.

Society of Exploration Geophysicists, P.O. Box 3098, Tulsa, Okla. 74101.

For information on Federal Government careers, contact:

Interagency Board of U.S. Civil Service Examiners for Washington, D.C., 1900 E St., NW., Washington, D.C. 20415.

METEOROLOGISTS

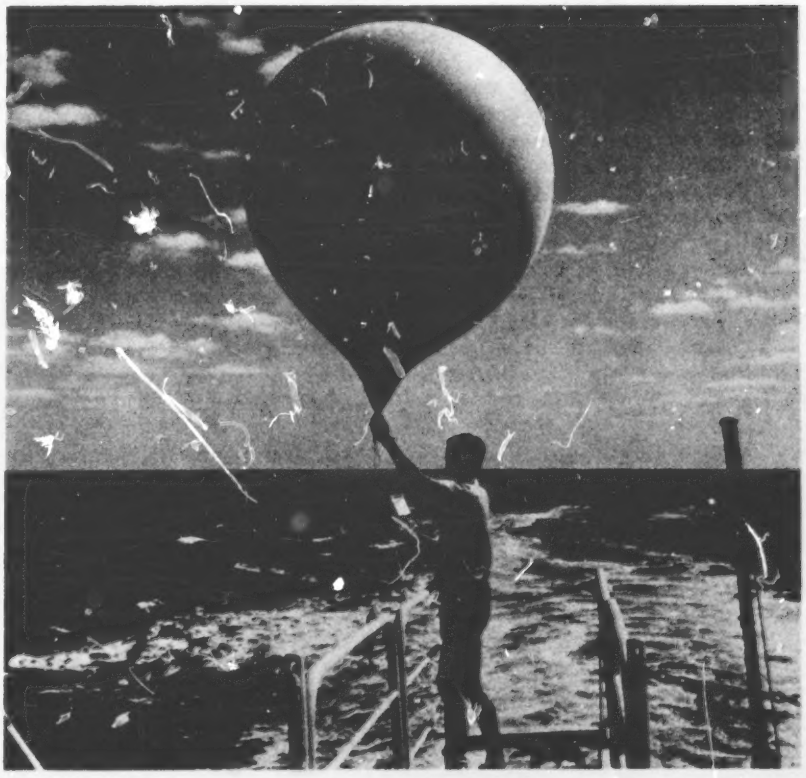
(D.O.T. 025.088)

Nature of the Work

Meteorology is the study of the atmosphere, which is the air that surrounds the earth. Meteorologists describe and try to understand the atmosphere's physical characteristics, motions, and processes, and determine the way the behavior of the atmosphere affects the rest of our physical environment. The best known application of this knowledge is in understanding and forecasting the weather. Meteorological research is also applied in many other areas not directly related to weather forecasting such as understanding and solving air pollution problems and studying trends in the earth's climate.

Meteorologists who specialize in forecasting the weather, known professionally as *synoptic meteorologists*, are the largest group of specialists. They study current weather information, such as air pressure, temperature, humidity, and wind velocity, in order to make short-range and long-range predictions. Their data come from weather satellites and observers in many parts of the world. Although some forecasters still prepare and analyze weather maps, most data now are plotted and analyzed by computers.

Some meteorologists are engaged in basic and applied research. For example, *physical meteorologists* study the chemical and electrical properties of the atmosphere. They do research on the effect of the atmosphere on transmission of light, sound, and radio waves, as well as study factors affecting formation of clouds, rain, snow, and other weather phenomena. Other meteorologists, known as *climatologists*, study climatic trends and analyze past records on wind, rainfall, sunshine, and temperature to determine the general pattern of weather that makes up an area's climate. These studies are useful in planning heating and cooling systems, designing buildings, and aiding in effective land utilization.



Meteorologist sending weather balloon aloft.

Other meteorologists apply their knowledge in the study of the relationship between weather and specific human activities, biological processes, and agricultural and industrial operations. For example, they may make weather forecasts for individual companies, or may work on problems such as smoke control and air pollution abatement.

About one-third of all civilian meteorologists work primarily in weather forecasting, and another one-third work in research and development. Almost one-fifth of all civilian meteorologists are in administrative or management positions.

Some meteorologists teach or do research—frequently combining both activities—in colleges and universities. In colleges without separate departments of meteorology, they may teach geography, mathematics, physics, chemistry, or geology, as well as meteorology.

Places of Employment

About 5,500 persons worked as meteorologists in 1976. In addition to these civilian meteorologists, thousands of members of the Armed Forces did forecasting and other meteorological work.

The largest employer of civilian meteorologists was the National Oceanic and Atmospheric Administration (NOAA), where over 1,800 worked at stations in all parts of the United States and in a small number

of foreign areas. The Department of Defense employed over 200 civilian meteorologists.

Almost 2,000 meteorologists worked for private industry. Commercial airlines employed several hundred to forecast weather along flight routes and to brief pilots on atmospheric conditions. Others worked for private weather consulting firms, for companies that design and manufacture meteorological instruments, and for firms in aerospace, insurance, engineering, utilities, radio and television, and other industries.

Colleges and universities employed over 1,300 meteorologists in research and teaching. A few worked for State and local governments and for nonprofit organizations.

Although meteorologists work in all parts of the country, nearly one-fifth live in just two States—California and Maryland. Almost one-tenth of all meteorologists work in the Washington, D.C. area.

Training, Other Qualifications, and Advancement

A bachelor's degree with a major in meteorology is the usual minimum requirement for beginning jobs in weather forecasting. However, a bachelor's degree in a related science or engineering, along with some courses in meteorology, is acceptable for some jobs. For example, the Federal Government's minimum requirement for beginning jobs is a bachelor's degree with at least 20 semester hours of study in meteorology and courses in physics and mathematics, including calculus. However, employers prefer to hire those with an advanced degree, and an advanced degree is increasingly necessary for advancement.

For research and college teaching and for many top-level positions in other meteorological activities, an advanced degree, preferably in meteorology, is essential. However, people with graduate degrees in other sciences also may qualify if they have advanced courses in meteorology, physics, mathematics, and chemistry.

In 1976, 44 colleges and universities offered a bachelor's degree in meteorology or atmospheric science; 59 schools offered advanced degrees. Many other institutions offered some courses in meteorology.

The Armed Services give and support meteorological training, both undergraduate education for enlisted personnel and advanced study for officers.

NOAA has a program under which some of its meteorologists attend college for advanced or specialized training. College students can obtain summer jobs with this agency or enroll in its cooperative education program in which they work at NOAA part of the year and attend school part of the year. In addition to helping students finance their education, this program gives them experience valuable for finding a job when they graduate.

Beginning meteorologists often start in jobs involving routine data collection, computation, or analysis. Experienced meteorologists may advance in academic rank or to various supervisory or administrative jobs. A few very well qualified meteorologists with a background in science, engineering, and business administration may establish their own weather consulting services.

Employment Outlook

Job opportunities for meteorologists should be favorable through the mid-1980's. Although the number of openings created by growth in the occupation and replacement needs is not expected to be large, the number of persons obtaining degrees in meteorology also is small. If trends in the number of degrees granted continue, the number of people seeking entry to the field will about equal requirements.

Employment in the field, as a whole, is expected to increase about as fast as the average for all occupations. Employment of meteorologists in industry and in weather consulting firms is expected to grow as private industry realizes the importance of meteorology to understanding and preventing air pollution. Many companies are also recognizing the value of having their own weather forecasting and meteorological services which can be tailored to fit their needs. There also should be some openings in radio and television as stations increasingly rely on their own meteorologists to prepare and deliver their weather reports. Colleges and universities will offer some job opportunities, especially for those with advanced degrees. The employment of civilian meteorologists by the Federal Government is not expected to grow significantly, although there will be openings created by replacement needs.

Earnings and Working Conditions

Meteorologists have relatively high earnings; their salaries are about twice the average for nonsupervisory workers in private industry, except farming.

In 1977, meteorologists in the Federal Government with a bachelor's degree and no experience received starting salaries of $9,303 or $11,523 a year, depending on their college grades. Those with a master's degree could start at $11,523 or $14,097, and those with the Ph. D. degree at $17,056 or $20,442. The average salary for meteorologists employed by the Federal Government was $24,500 in 1977.

Airline meteorologists' salaries ranged from about $16,000 to $24,000 a year in 1976, depending on experience. (See Statement on Occupations in Civil Aviation elsewhere in the *Handbook*.)

Jobs in weather stations, which are operated around the clock 7 days a week, often involve nightwork and rotating shifts. Most stations are at airports or in or near cities; some are in isolated and remote areas. Meteorologists in smaller weather stations generally work alone; in larger ones, they work as part of a team.

Sources of Additional Information

General information on career opportunities in meteorology is available from:

American Meteorological Society, 45 Beacon St., Boston, Mass. 02108.

American Geophysical Union, 1909 K St. NW., Washington, D.C. 20006.

For facts about job opportunities with the NOAA National Weather

Service and its student cooperative education program, contact:

Personnel Operations Branch, AD 41, National Oceanic and Atmospheric Administration, 6001 Executive Blvd., Rockville, Md. 20852.

OCEANOGRAPHERS

(D.O.T. 024.081 and 041.081)

Nature of the Work

Oceans cover more than two-thirds of the earth's surface and are a source of valuable foods, fossil fuels, and minerals. They also influence the weather, serve as a "highway" for transportation, and offer many kinds of recreation. Oceanographers use the principles and techniques of natural science, mathematics, and engineering to study oceans—their movements, physical properties, and plant and animal life. Their research not only extends basic scientific knowledge, but also helps develop practical methods for forecasting weather, developing fisheries, mining ocean resources, and improving national defense.

Most oceanographers test their ideas about the ocean by making observations and conducting experiments at sea. They may study and collect data on ocean tides, currents, and other phenomena. They may study undersea mountain ranges and valleys, oceanic interactions with the atmosphere, and layers of sediment on and beneath the ocean floor.

Many oceanographers work primarily in laboratories on land where, for example, they measure, dissect, and photograph fish. They also study sea specimens and plankton (floating microscopic plants and animals). Much of their work entails identifying, cataloging, and analyzing different kinds of sea life and minerals. At other laboratories, oceanographers plot maps or use computers to test theories about the ocean. For example, they may study and test the theory of continental drift, which states that the continents were once joined together, have drifted to new positions, and continue to drift, causing the sea floor to spread in places. To present the results of their studies, oceanographers prepare charts, tabulations, and reports, and write papers for scientific journals.

Four out of ten oceanographers work in just three States—California, Maryland, and Virginia.

Oceanographers explore and study the ocean with surface ships, aircraft, and various types of underwater craft. They use specialized instruments to measure and record the findings of their explorations and studies. Special cameras equipped with strong lights are used to photograph marine life and the ocean floor. Sounding devices are used to measure, map, and locate ocean materials.

Most oceanographers specialize in one branch of the science. *Biological oceanographers* (marine biologists) study plant and animal life in the ocean. The biological oceanographer's research has practical applications in improving and controlling commercial and sport fishing and in determining the effects of pollution on marine life. *Physical oceanographers* (physicists and geophysicists) study the physical properties of the ocean. Their research on the relationships between the sea and the at-

mosphere may lead to more accurate prediction of the weather. *Geological oceanographers* (marine geologists) study the ocean's underwater mountain ranges, rocks, and sediments. Locating regions where minerals, oil, and gas might be found under the ocean floor is an application of their work. *Chemical oceanographers* investigate the chemical composition of ocean water and sediments as well as chemical reactions in the sea. *Oceanographic engineers* and *electronic specialists* design and build instruments for oceanographic research and operations. They also lay cables and supervise underwater construction.

Many other scientists also work on problems related to oceans, but are counted in other scientific fields such as biology, chemistry, or geology.

Places of Employment

About 2,700 persons worked as oceanographers in 1976. About one-half worked in colleges and universities, and more than one-fourth for the Federal Government. Federal agencies employing substantial numbers of oceanographers include the Navy and the National Oceanic and Atmospheric Administration (NOAA). Some oceanographers work in private industry; a few work for fishery laboratories of State and local governments.

Most oceanographers work in States that border on the ocean, although there are some oceanographers employed in almost every State. Four out of 10 oceanographers work in just three States—California, Maryland, and Virginia.

Training, Other Qualifications, and Advancement

The minimum requirement for beginning professional jobs in oceanography is a bachelor's degree with a major in oceanography, biology, earth or physical sciences, mathematics, or engineering. However, most jobs in research, teaching, and high-level positions in most other types of oceanographic work require graduate training in oceanography or a basic science, and a doctoral degree is often preferred or required for many oceanography positions.

About 35 colleges and universities offered undergraduate degrees in oceanography or marine sciences in 1976. However, undergraduate training in a basic science and a strong interest in oceanography may be adequate preparation for some beginning jobs and is the preferred background for graduate training in oceanography.

College courses needed to prepare for graduate study in oceanography include mathematics, physics, chemistry, geophysics, geology, meteorology, and biology. In general, students should specialize in the particular science that is closest to their area of oceanographic interest. For example, students interested in chemical oceanography could obtain a degree in chemistry.

In 1976, about 65 colleges offered advanced degrees in oceanography and marine sciences. In graduate schools, students take advanced courses in oceanography and in basic sciences.

Graduate students usually work part of the time aboard ship, where they do oceanographic research and become familiar with the sea and with techniques used to obtain oceanographic information. Universities having oceanographic research facilities along our coasts offer summer courses for both graduate and undergraduate students. Oceanographers should have the curiosity needed to do research and the patience to collect data and conduct experiments.

Beginning oceanographers with the bachelor's degree usually start as research or laboratory assistants, or in jobs involving routine data collection, computation, or analysis. Most beginning oceanographers receive on-the-job training. The extent of the training varies with the background and needs of the individual.

Experienced oceanographers often direct surveys and research programs or advance to administrative or supervisory jobs in research laboratories.

Employment Outlook

Persons seeking jobs in oceanography may face competition through the mid-1980's. Those with a Ph. D. degree should have more favorable employment opportunities than others while those with less education may find opportunities limited to routine analytical work as research assistants or technicians. Persons who combine knowledge of other scientific or engineering fields with oceanographic studies should have better employment prospects than others whose knowledge is limited to oceanography.

Employment of oceanographers is expected to grow about as fast as the average for all occupations. This growth will result from increased awareness of the need for ocean research for understanding and controlling pollution, for recovering offshore oil and other natural resources, and for national defense. However, growth in employment may not be rapid enough to create enough openings for all those expected to seek entry into this relatively small field. Since the Federal Government finances most oceanographic research, a large increase in Federal spending in oceanography could improve employment prospects.

Earnings and Working Conditions

Oceanographers have relatively high earnings. Their average salaries were more than twice the average received by nonsupervisory workers in private industry, except farming.

In 1977, oceanographers in the Federal Government with a bachelor's degree received starting salaries of $9,303 or $11,523 a year, depending on their college grades. Those with a master's degree could start at $11,523 or $14,097; and those with a Ph. D. degree at $17,056 or $20,442. The average salary for experienced oceanographers in the Federal Government in 1977 was about $23,800 a year.

Oceanographers in educational institutions generally receive the same salaries as other faculty members. (See statement on College and University Teachers elsewhere in the *Handbook*.) In addition to regular salaries, many earn extra income from consulting, lecturing, and writing.

Oceanographers engaged in research that requires sea voyages are

frequently away from home for weeks or months at a time. Sometimes they live and work in cramped quarters. People who like the sea and oceanographic research often find these voyages satisfying and do not consider the time spent at sea a disadvantage of their work.

Sources of Additional Information

For information about careers in oceanography, contact:

Dr. C. Schelske, Secretary, American Society of Limnology and Oceanography, Great Lakes Research Division, University of Michigan, Ann Arbor, Mich. 48109.

Federal Government career information is available from any regional office of the U.S. Civil Service Commission or from:

U.S. Civil Service Commission, Washington Area Office, 1900 E St. NW., Washington, D.C. 20415.

The booklet, *Training and Careers in Marine Science*, is available for fifty cents from:

International Oceanographic Foundation, 3979 Rickenbacker Causeway, Virginia Key, Miami, Fla. 33149.

Some information on oceanographic specialties is available from professional societies listed elsewhere in the *Handbook*. (See statements on Geologists, Geophysicists, Life Scientists, Meteorologists, and Chemists.)

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What to Look For in this Reprint

To make the *Occupational Outlook Handbook* easier to use, each occupation or industry follows the same outline. Separate sections describe basic elements, such as work on the job, education and training needed, and salaries or wages. Some sections will be more useful if you know how to interpret the information as explained below.

The TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT section indicates the preferred way to enter each occupation and alternative ways to obtain training. Read this section carefully because early planning makes many fields easier to enter. Also, the level at which you enter and the speed with which you advance often depend on your training. If you are a student, you may want to consider taking those courses thought useful for the occupations which interest you.

Besides training, you may need a State license or certificate. The training section indicates which occupations generally require these. Check requirements in the State where you plan to work because State regulations vary.

Whether an occupation suits your personality is another important area to explore. For some, you may have to make responsible decisions in a highly competitive atmosphere. For others, you may do only routine tasks under close supervision. To work successfully in a particular job, you may have to do one or more of the following:

- motivate others
- direct and supervise others
- work with all types of people
- work with things—you need good coordination and manual dexterity
- work independently—you need initiative and self-discipline
- work as part of a team
- work with details, perhaps numbers or laboratory reports
- help people
- use creative talents and ideas
- work in a confined area
- do physically hard or dangerous work
- work outside in all types of weather

A counselor can help you find out more about your interests and abilities so you can judge whether a job's characteristics suit you.

The EMPLOYMENT OUTLOOK section tells whether or not the job market is likely to be favorable. Usually an occupation's expected growth is compared to the average projected growth rate for all occupations (20.1 percent between 1976 and 1985). The following phrases are used:

Much faster	50% or more
Faster	25.0 to 49.9%
About as fast	15.0 to 24.9%
Slower	4.0 to 14.9%
Little change	3.9 to -3.9%
Decline	-4.0% or more

Generally, job opportunities are favorable if employment is growing at least as fast as for the economy as a whole.

But, you would have to know the number of people competing with you to be sure of your prospects. Unfortunately, this supply information is lacking for most occupations.

There are exceptions, however, especially among professional occupations. Nearly everyone who earns a medical degree, for example, becomes a practicing physician. When the number of people pursuing relevant types of education and training and then entering the field can be compared with the demand, the outlook section indicates the supply/demand relationship as follows:

Excellent	Demand much greater than supply
Very good	Demand greater than supply
Good or favorable	Rough balance between demand and supply
May face competition	Likelihood of more supply than demand
Keen competition	Supply greater than demand

Competition or few job openings should not stop your pursuing a career that matches your aptitudes and interests. Even small or overcrowded occupations provide some jobs. So do those in which employment is growing very slowly or declining.

Growth in an occupation is not the only source of job openings because the number of openings from turnover can be substantial in large occupations. In fact, replacement needs are expected to create 70 percent of all openings between 1976 and 1985.

Finally, job prospects in your area may differ from those in the Nation as a whole. Your State employment service can furnish local information.

The EARNINGS section tells what workers were earning in 1976.

Which jobs pay the most is a hard question to answer because good information is available for only one type of earnings—wages and salaries—and not even this for all occupations. Although 9 out of 10 workers receive this form of income, many earn extra money by working overtime, night shifts, or irregular schedules. In some occupations, workers also receive tips or commissions based on sales or service. Some factory workers are paid a piece rate—an extra payment for each item they make.

The remaining 10 percent of all workers—the self-employed—includes people in many occupations—physicians, barbers, writers, and farmers, for example. Earnings for self-employed workers even in the same occupation differ widely because much depends on whether one is just starting out or has an established business.

Most wage and salary workers receive fringe benefits, such as paid vacations, holidays, and sick leave.

Workers also receive income in goods and services (payment in kind). Sales workers in department stores, for example, often receive discounts on merchandise.

Despite difficulties in determining exactly what people earn on the job, the Earnings section does compare occupational earnings by indicating whether a certain job pays more or less than the average for all nonsupervisors in private industry, excluding farming.

Each occupation has many pay levels. Beginners almost always earn less than workers who have been on the job for some time. Earnings also vary by geographic location but cities that offer the highest earnings often are those where living costs are most expensive.

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The career information contained in the reprint you are reading was taken from the 1978-79 edition of the Occupational Outlook Handbook. But the Handbook is not the only source of useful career information published by the Bureau of Labor Statistics. The Handbook's companion, the Occupational Outlook Quarterly, is published four times during the school year to keep subscribers up to date on new occupational studies completed between editions of the Handbook. The Quarterly also gives practical information on training and educational opportunities, salary trends, and new and emerging jobs—just what people need to know to plan careers.

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